

## **AMENDMENTS TO THE CLAIMS**

This listing of claims will replace all prior versions, and listings, of claims in the application:

### **Listing of Claims**

1. A system for mapping a surface of a three-dimensional object, comprising:
  - a projecting optical system adapted to project light onto an object;
  - a pre-correction system adapted to compensate a light beam to be projected onto the object for at least one aberration in the object, the pre-correction system being positioned in between the projecting optical system and the object;
  - an imaging system adapted to collect light scattered by the object; and
  - a wavefront sensor adapted to receive the light collected by the imaging system and to sense a wavefront of the received light.
  
2. The system of claim 1, further comprising:
  - means for adjusting the compensation applied to the light beam by the pre-correction system to thereby change the wavefront of the light received by the wavefront sensor; and
  - means for stitching together the sensed wavefronts of the light received by the wavefront sensor for each compensation to map the surface of the object.

3. The system of claim 1, wherein the wavefront sensor is a Shack-Hartmann wavefront sensor.
4. The system of claim 1, further comprising a dynamic-range-limiting aperture adapted to insure that the wavefront sensor only sees light within a dynamic range of the system.
5. The system of claim 1, wherein the pre-correction system includes at least one variable focal length lens.
6. The system for measuring errors of claim 5, wherein the pre-correction system includes a processor controlling the variable focal length lens.
7. The system of claim 1, wherein the pre-correction system comprises a telescope having two lenses, at least one of said lenses being movable.
8. The system of claim 7, further comprising a processor adapted to move said movable lens to a plurality of positions and to stitch together the sensed wavefronts of the light received by the wavefront sensor at each of the positions.
9. The system of claim 7, further comprising further comprising a

dynamic-range-limiting aperture disposed in an optical path between the two lenses and being adapted to insure that the wavefront sensor only sees light within a dynamic range of the system.

10. The system of claim 9, further comprising a processor adapted to move said movable lens to a plurality of positions and to stitch together the sensed wavefronts of the light received by the wavefront sensor at each of the positions.

11. A method of mapping an object, comprising:

- (a) projecting a light beam onto an object;
- (b) compensating the light beam to be projected onto the object for at least one aberration in the object;
- (c) collecting light scattered by the object and providing the collected light to a wavefront sensor; and
- (d) sensing at the wavefront sensor a wavefront of the collected light scattered by the object.

12. The method of claim 11, further comprising:

- (e) changing a compensation applied to the light beam;
- (f) repeating steps (b) through (e) to obtain N sensed wavefronts; and
- (f) stitching together the N sensed wavefronts to map the object.

13. The method of claim 11, further comprising passing the light scattered from the object through a dynamic-range-limiting aperture adapted to insure that the wavefront sensor only sees light within a dynamic range of the wavefront sensor.

14. The method of claim 11, wherein compensating the light beam comprises passing the light beam through a telescope having two lenses, at least one of said lenses being movable.

15. The method of claim 14, further comprising:

(e) moving said movable lens to a plurality of positions; and

(f) stitching together the sensed wavefronts of the light received by the wavefront sensor at each of the positions.

16. The method of claim 14, further comprising further comprising further comprising passing the light scattered from the object through a dynamic-range-limiting aperture disposed in an optical path between the two lenses adapted to insure that the wavefront sensor only sees light within a dynamic range of the wavefront sensor.

17. The method of claim 16, further comprising :

(e) moving said movable lens to a plurality of positions; and

(f) stitching together the sensed wavefronts of the light received by the

wavefront sensor at each of the positions.

18. A system for measuring an optical characteristic of an optically transmissive object, comprising:

a projecting optical system which projects light through an optically transmissive object;

a correction system adapted to at least partially compensate a light beam that has been projected through the object for at least one optical property of the object;

an imaging system adapted to collect the light that has been projected through the object; and

a wavefront sensor adapted to receive the light collected by the imaging system and to sense a wavefront of the received light.

19. The system of claim 18, wherein the object is a lens and the optical property that the correction system compensates for is a focal power of the lens.

20. The system of claim 18, further comprising means for adjusting the compensation applied to the light beam by the correction system.

21. The system of claim 18, wherein the wavefront sensor is a Shack-Hartmann wavefront sensor.

22. The system of claim 18, further comprising a dynamic-range-limiting aperture adapted to insure that the wavefront sensor only sees light within a dynamic range of the system.

23. The system of claim 18, wherein the correction system includes at least one variable focal length lens.

24. The system for measuring errors of claim 23, wherein the correction system includes a processor controlling the variable focal length lens.

25. The system of claim 18, wherein the correction system comprises a telescope having two lenses, at least one of said lenses being movable.

26. The system of claim 25, further comprising a processor adapted to move said movable lens to a plurality of positions and to stitch together the sensed wavefronts of the light received by the wavefront sensor at each of the positions.

27. The system of claim 25, further comprising further comprising a dynamic-range-limiting aperture disposed in an optical path between the two lenses and being adapted to insure that the wavefront sensor only sees light within a dynamic range of the system.

28. The system of claim 27, further comprising a processor adapted to move said movable lens to a plurality of positions and to stitch together the sensed wavefronts of the light received by the wavefront sensor at each of the positions.

29. A method of measuring an optical quality of an optically transmissive object, comprising:

- (a) projecting a light beam through an optically transmissive object;
- (b) at least partially compensating the light beam that has been projected through the object for at least one optical property of the object;
- (c) collecting the light beam that has been projected through the object and providing the collected light to a wavefront sensor; and
- (d) sensing at the wavefront sensor a wavefront of the collected light.

30. The method of claim 29, wherein the object is a lens and wherein at least partially compensating the light beam that has been projected through the object for at least one optical property of the object includes compensating for a focal power of the lens.

31. The method of claim 30, where the method measures the focal power of the lens.

32. The method of claim 29, further comprising:

- (e) changing a compensation applied to the light beam;
- (f) repeating steps (b) through (e) to obtain N sensed wavefronts; and
- (f) stitching together the N sensed wavefronts to map the object.

33. The method of claim 29, further comprising passing through a dynamic-range-limiting aperture the light beam that has been projected through the object, the dynamic-range-limiting aperture being adapted to insure that the wavefront sensor only sees light within a dynamic range of the wavefront sensor.

34. The method of claim 29, wherein compensating the light beam comprises passing the light beam through a telescope having two lenses, at least one of said lenses being movable.

35. The method of claim 34, further comprising:

- (e) moving said movable lens to a plurality of positions; and
- (f) stitching together the sensed wavefronts of the light received by the wavefront sensor at each of the positions.

36. The method of claim 34, further comprising further comprising further comprising passing through a dynamic-range-limiting aperture the light beam that has been projected through the object, the dynamic-range-limiting



aperture being disposed in an optical path between the two lenses and being adapted to insure that the wavefront sensor only sees light within a dynamic range of the wavefront sensor.

37. The method of claim 36, further comprising :

- (e) moving said movable lens to a plurality of positions; and
- (f) stitching together the sensed wavefronts of the light received by the wavefront sensor at each of the positions.

38. A method of mapping a surface of an object, comprising:

- (a) projecting a light beam onto a surface of an object;
- (b) collecting light scattered by a first portion of the surface of the object and rejecting light scattered by a second portion of the surface of the object;
- (c) sensing at a wavefront sensor a wavefront of the collected light returned by the portion of the surface of the object;
- (d) repeating steps (a) through (c) for a plurality of different portions of the surface of the object that together span a target area of the surface of the object; and
- (e) stitching together the sensed wavefronts to produce a complete measurement of the target area of the surface of the object.

39. The method of claim 38, wherein collecting light scattered by a first portion of the surface of the object and rejecting light scattered by a second

portion of the surface of the object comprises passing the light scattered by the first and second portions through a dynamic-range-limiting aperture adapted to insure that the wavefront sensor only sees light within a dynamic range of the wavefront sensor.

40. The method of claim 38, wherein collecting light scattered by a first portion of the surface of the object comprises passing through a telescope having two lenses the light scattered by a first portion of the surface of the object, at least one of said lenses being movable, and wherein repeating steps (a) through (c) for a plurality of different portions of the surface of the object comprises moving the movable lens to a plurality of different positions.

41. The method of claim 40, wherein collecting light scattered by a first portion of the surface of the object and rejecting light scattered by a second portion of the surface of the object comprises passing the light scattered by the first and second portions through a dynamic-range-limiting aperture disposed in an optical path between the first and second lenses, the dynamic-range-limiting aperture being adapted to insure that the wavefront sensor only sees light within a dynamic range of the wavefront sensor.

42. A method of measuring an optically transmissive object, comprising:

(a) projecting a light beam through at least a portion of an object;

- (b) collecting light passed through the portion of the object;
- (c) sensing at a wavefront sensor a wavefront of the collected light passed through the portion of the object;
- (d) repeating steps (a) through (c) for a plurality of different portions of the object that together span a target area of the object; and
- (e) stitching together the sensed wavefronts to produce a complete measurement of the target area of the object.

43. The method of claim 42, further comprising passing through a dynamic-range-limiting aperture the light passed through the portion of the object, the a dynamic-range-limiting aperture being adapted to insure that the wavefront sensor only sees light within a dynamic range of the wavefront sensor.

44. The method of claim 42, wherein collecting light passed through the portion of the object comprises passing through a telescope having two lenses the light passed through the portion of the object, at least one of said lenses being movable, and wherein repeating steps (a) through (c) for a plurality of different portions of the surface of the object comprises moving the movable lens to a plurality of different positions.

45. The method of claim 44, further comprising passing through a dynamic-range-limiting aperture the light passed through the portion of the

object, the a dynamic-range-limiting aperture being adapted to insure that the wavefront sensor only sees light within a dynamic range of the wavefront sensor.

46. A method of mapping a surface of an object, comprising:

- (a) locating a light source a first distance from an object;
- (b) projecting a light beam from the light source onto a surface of the object;
- (c) collecting light scattered by the surface of the object;
- (d) sensing at a wavefront sensor a wavefront comprising a difference between a wavefront of the collected light and a reference wavefront;
- (e) changing the distance between the light source and the object;
- (f) repeating steps (b) through (e) to produce N sensed wavefronts; and
- (g) stitching together the N sensed wavefronts to produce a complete measurement of the target area of the surface of the object.

47. A method of measuring an optically transmissive object, comprising:

- (a) locating a light source a first distance from an optically transmissive object;
- (b) projecting a light beam from the light source through the object;
- (c) collecting light projected through the object;
- (d) sensing a wavefront comprising a difference between a wavefront of

the collected light and a reference wavefront;

(e) changing the distance between the light source and the object;

(f) repeating steps (b) through (e) to produce N sensed wavefronts; and

(g) stitching together the N sensed wavefronts to produce a complete measurement of the target area of the surface of the object.

Claims 48-50 (canceled).

51. A method of determining when a portion of a light wavefront received by a wavefront sensor exceeds the dynamic range of the wavefront sensor, the method comprising:

assigning a group of N pixels of a wavefront sensor to a focal spot;

providing a first light wavefront to the wavefront sensor under conditions known to be within a dynamic range of the wavefront sensor;

calculating a reference value,  $\sigma_k^{REF}$ , for a second moment of the focal spot produced by the first light wavefront within the group of N pixels;

providing a second light wavefront to the wavefront sensor;

calculating a value of the  $\sigma_k$ , for a second moment of the focal spot produced by the second light wavefront within the group of N pixels; and

determining that the second light wavefront is within the dynamic range of the wavefront sensor within the group of N pixels when  $|\sigma_k - \sigma_k^{REF}| < t_\sigma$ ,

where  $t_\sigma$  is a set threshold value.

52. The method of claim 51, where  $t_0$  is set to be at least twice an average of reference second moment values of a plurality of groups of N pixels spanning the wavefront sensor.

53. A method of mapping a surface of an object, comprising:  
projecting a light beam onto an object;  
compensating the light beam to be projected onto the object for aberrations in the object;  
passing light scattered by the object through a dynamic-range-limiting aperture;  
collecting light passed through the dynamic-range-limiting aperture and providing the collected light to a wavefront sensor; and  
sensing a wavefront of the collected light.

54. The method of claim 53, wherein the wavefront of the collected light is sensed with a Shack-Hartmann wavefront sensor having a first plurality of lenslets for receiving and focusing the wavefront into focal spots, and a second plurality of pixels adapted to receive the focal spots, and wherein the dynamic-range-limiting aperture has a same shape as a shape of one of the lenslets.

55. The method of claim 53, where the dynamic-range-limiting aperture has a rectangular shape.

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Claims 56-59 (canceled).